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Research
U.S. DEPARTMENT OF AGRICULTURE

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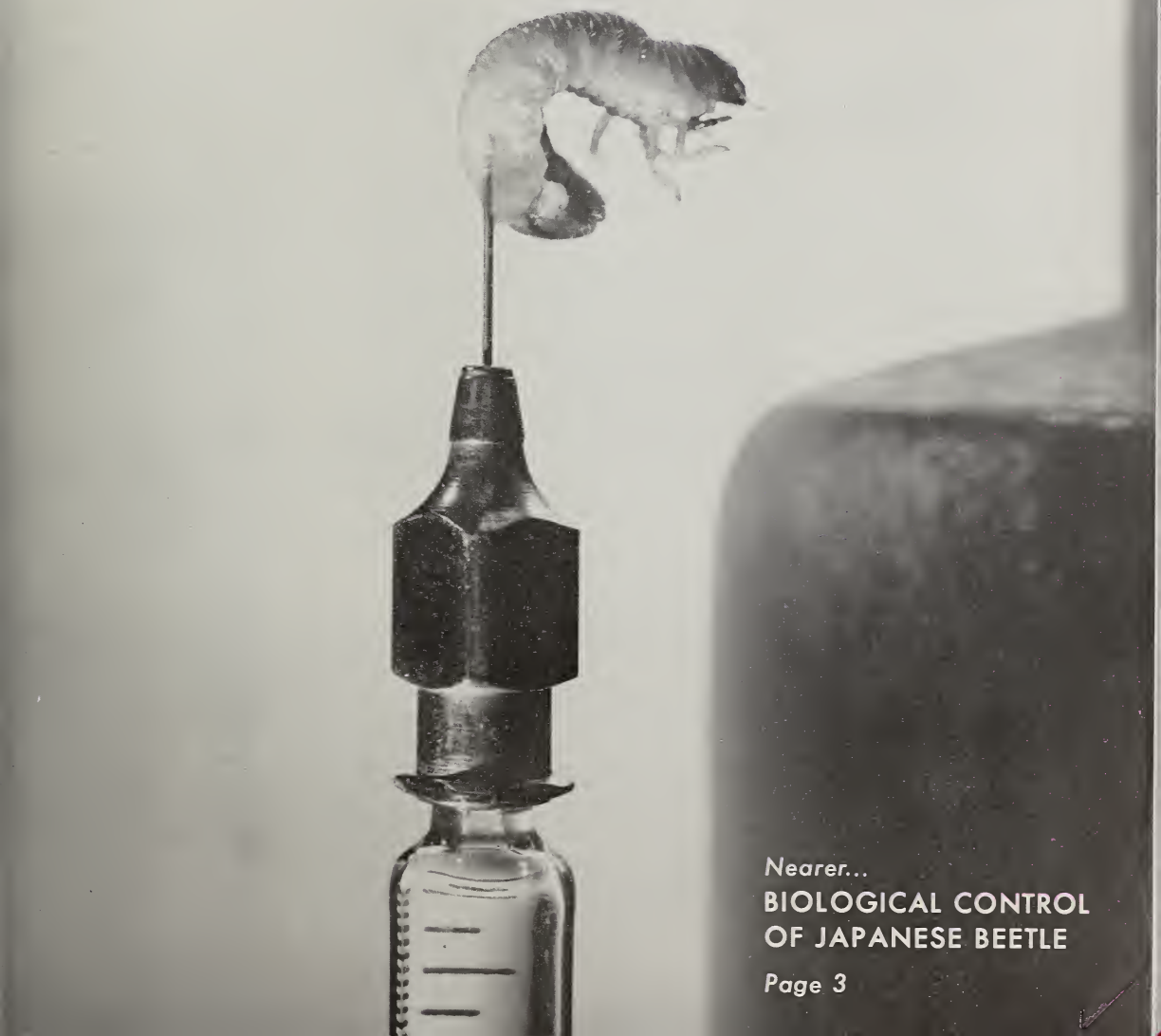

Nearer...

BIOLOGICAL CONTROL OF JAPANESE BEETLE

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Studies in Detail

Even the smallest detail about an insect may lead to a better method of controlling it. For this reason, ARS scientists are giving closer scrutiny than ever before to our major insect pests and their living habits.

This approach made possible the sterile-male technique of insect eradication—a development regarded by many as one of the truly original scientific ideas of this century. The sterile-male technique eradicated the screwworm from the Southeastern United States—and more recently, the melon fly from the Pacific island of Rota (p. 5 of this issue). Entomologists first, however, had to study the insects closely: their environment, their population densities, factors regulating their rate of increase, and why and how they disperse.

An examination of insects led also to the discovery that they respond to certain vital natural attractants. Synthetic attractants, imitating the natural ones, have already proved highly successful in campaigns against the gypsy moth and the Mediterranean fruitfly.

Knowing the natural enemies of insects has made it possible for researchers to establish more than 100 parasites, predators, and diseases against 50 different pests in the United States. One of these is milky disease, which attacks and kills the Japanese beetle. This beetle, confined largely to the Northeast for the past 40 years, remains a constant threat to the main crop-producing areas of the country. It has an appetite for well over 200 plants common to U.S. farms, gardens, orchards, and lawns.

Knowledge of the beetle in its various stages helped scientists learn how to infect beetle grubs with the deadly milky disease, then harvest and use the disease spores as a weapon against the pest. Milky disease has been used extensively by homeowners in the Northeast, but the use of infected grubs as a source of the spores is not practical for an all-out attack on this pest.

Now, however, new information about the grub itself may have opened an avenue for mass production of the spores (p. 3 of this issue).

ARS scientists have succeeded in duplicating the complex environment of the hemolymph ("blood") of the grub. In this artificial environment, they have been able to grow cells and spores of the milky disease. Further research along this line may well make it possible to eradicate the Japanese beetle.

Contents

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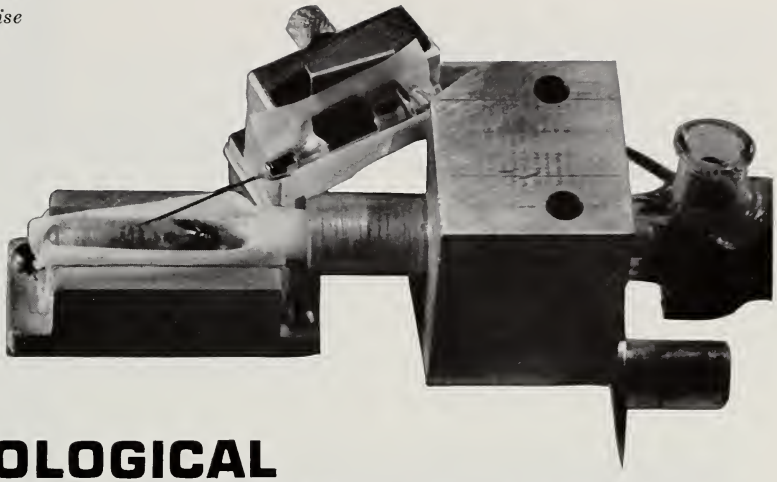
U. S. Department of Agriculture

B. T. Shaw, Administrator,
Agricultural Research Service

Scientists are gaining on a practical way to mass-produce spores that cause milky disease in Japanese beetle grubs. A small electrode in a hypodermic needle (right) permits precise measurement of the oxygen level in the hemolymph of a Japanese beetle grub.



Nearer...

MASS BIOLOGICAL CONTROL OF JAPANESE BEETLE

■ A way to mass-produce bacterial spores that cause milky disease of Japanese beetles is the goal of a team of ARS scientists at the Northern utilization research laboratory, Peoria, Ill.

Their approach: First, grow large populations of the bacterial cells by industrial fermentation methods; then, induce these artifically grown cells to form spores—a dormant stage—capable of surviving in soil and causing disease when ingested by beetle grubs.

If the scientists succeed, the United States will have a *low cost,* effective biological control for Japanese beetle.

Grubs can't produce enough

Milky disease spores now used as a soil treatment by many eastern homeowners are produced in diseased beetle grubs. But this method is not practicable for producing spores in the quantities needed by farmers and by plant pest control officials charged with preventing the relentless westward spread of the Japanese beetle.

Now in its fourth year, the study at the Northern laboratory shows progress even though milky disease bacteria require a complex environment and are difficult to grow outside the beetle grub. The scientists have succeeded in growing cells in liquid nutrients, but inducing the cells to form spores has proved a tougher problem.

A billion cells per milliliter

Up to a billion cells per milliliter of liquid medium (about a fifth of a teaspoonful) have been produced in bench-top fermentors. The medium contains yeast extract, corn sugar, and potassium phosphate, which buffers lactic and acetic acids produced by the growing cells and thus prolongs the life of the culture. Oxygen is provided by aeration.

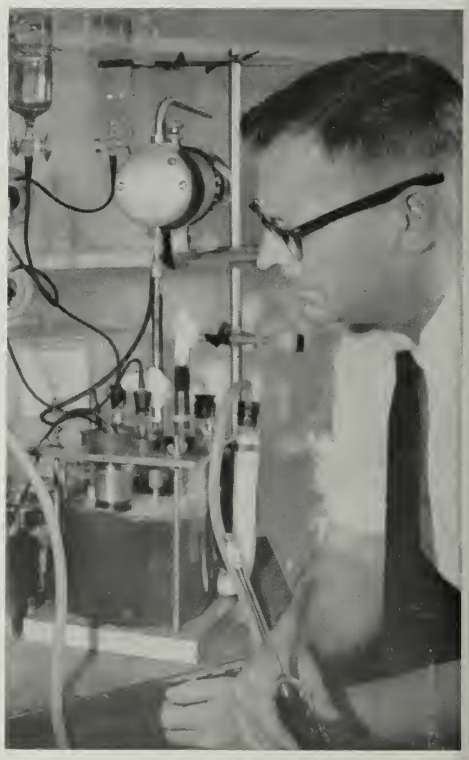
In another study, up to 2 percent of the cells growing on a solid medium have sporulated. There have been too few spores, however, to be tested for infectivity—the ability to cause milky disease.

This is the first time sporulation has

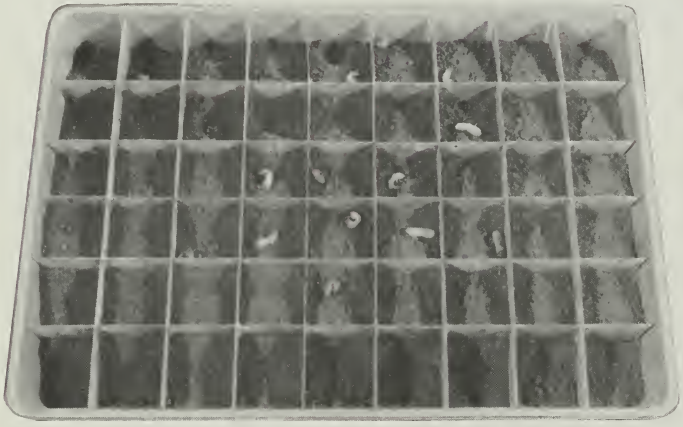
Turn Page

been induced by conventional fermentation methods, but the requirements are exacting. For example, the sporulation medium must be free of glucose. Acetate, a derivative of acetic acid (vinegar), is required.

Eugene Sharpe developed this bench-top fermentor in which cells of the milky disease have been grown. It maintains the same pH in the liquid medium as that in the hemolymph of the grub.



Once inoculated with the disease organism, grubs are placed in compartments until disease develops.



Acetate's effect on sporulation

Presence of acetate may have even greater significance in sporulation than has been found so far. H. H. Hall, who is leading the Peoria studies, says: "This is the one item that has been found to be common to several areas of the investigation. Acetic acid is produced by the growing bacterial cells; it is an important component of the grub hemolymph ('blood'); unless acetic acid is buffered, it shortens the life of the cell colonies; when it is buffered, the cells sporulate on a solid medium."

Oxygen decreases as cells multiply

Precise measurement of oxygen in beetle grub hemolymph was made possible by the development of an electrode small enough to be inserted into grubs. The scientists found that the oxygen level in the blood of infected grubs decreases as bacterial cells multiply but increases when the cells begin to form spores.

Analyses showed 20 amino acids and two unidentified nitrogen compounds in beetle grub hemolymph. The bacteria's requirements for these protein components, and for vitamins, are supplied by the yeast extract in the liquid medium.

A method for determining infectivity of cells injected into grubs has been developed, which enables the scientists to select strains of bacteria for infectivity and to insure that their disease-producing ability is not lost. Selected strains have been preserved for at least 20 months by freeze-drying. These preserved bacterial cells remain viable and infective.

In these preservation studies, the scientists discovered a factor that is essential for growth of some milky disease bacteria. This growth factor was found in tap water and agar but has yet to be identified.

R. W. Jackson, chief of the laboratory's fermentation research, is coordinating this broad ARS effort, which is cooperative with the Entomology Research Division and the Plant Pest Control Division and includes contract research by Illinois, Minnesota, Kansas State and Michigan State universities.☆

Male-sterile technique wipes out costly pest on Pacific island of Rota

ERADICATING THE MELON FLY

■ Entomologists armed with the sterile-male technique have eradicated the melon fly on the Pacific island of Rota.

This pest, which attacks cucurbits (melons, cucumbers, pumpkins, and related crops) as well as string beans and tomatoes, is a serious obstacle to the agricultural development of that part of the world. Crop damage comes after the adult female pierces the skin of ripening fruit of the host plant and lays clusters of eggs in the fleshy tissue. In about 2 days the eggs hatch into maggots. Once they begin feeding, decay of the fruit soon follows.

Intercepted at California ports

Since 1897 the melon fly has been a problem in Hawaii. Although it has been contained there, its presence poses a constant threat to U.S. mainland vegetable and fruit growers because frequent ship and plane communication with California holds open the possibility of accidental introduction. Plant quarantine inspectors at California ports intercept melon flies every year.

Through the use of bioclimatic cabinets—devices that duplicate selected temperatures and humidities—scientists have established that melon flies could thrive in some of the subtropical areas of the United States. This fact, coupled with the melon fly's strong flying ability, would complicate quarantine and control measures in new areas of melon fly infestation.

In the Rota campaign, ARS scientists released massive numbers of melon flies made sterile by exposure to gamma rays. When sterile males—either dropped from aircraft or released from cages on the ground—mated with native flies, the resulting eggs did not hatch, thus reducing the new generation. These repeated and

systematic releases eventually wiped out the native flies.

Before the first release of sterile flies, workers sprayed the borders of producing farms three times with bait sprays to reduce the wild fly population by 90 percent. Without this reduction, USDA's Hawaii "fly factory" could not produce the number of sterile flies needed to overwhelm the heavy initial population.

180 million sterile flies

Last September scientists began weekly releases of 4 to 10 million sterile flies, until a total of 180 million had been released. Within three weeks the sterile flies "overflooded" the native fly population by a ratio of 13 to 1. By early December overflooding was 50 to 1, and it reached 100 to 1 by early January. Scientists consider a ratio of more than 10 sterile flies to 1 native fly as effective overflooding.

Scientists on Rota have not detected any melon fly maggots in watermelons, pumpkins, or cucumbers since last December 26. Average infestation in the first 4 months of 1960, 1961, and 1962 ranged from 4.5 larvae per pound in tomatoes to 30 in immature cantaloupes.

Rota, a 33-square-mile island in the Mariana group, was selected for these tests because of its size and isolation. It is small enough to permit the economical treatment of an entire area of infestation with the available research resources; and the nearest land, Guam, is 37 miles away—far enough to prevent or greatly reduce chances of reinvasion by flight.

Others helped in the campaign

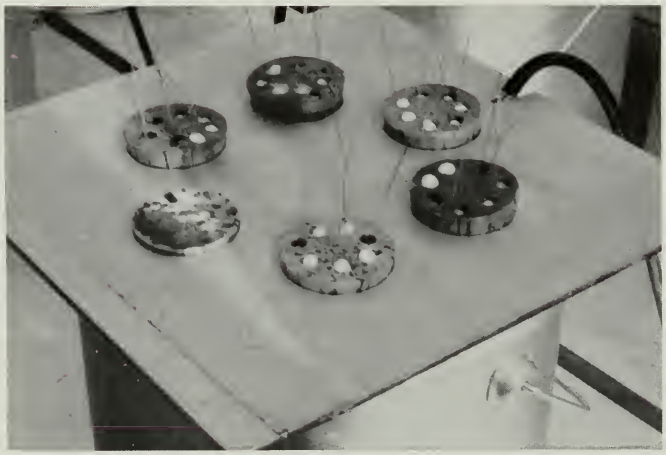
The U.S. Navy and the Trust Territory of the Pacific Islands cooperated in this effort by lending aircraft, boats, personnel, and facilities.

The sterile-male technique was first used successfully against another serious pest—the screwworm—which before its eradication in the Southeastern United States in 1958 had cost the cattle industry there $10 to $20 million a year. This technique is now being used to combat screwworms in the Southwest.☆

Tissue sampling has advantages over soil testing in . . .

DETECTING NITRATE LEVELS

The researchers controlled nitrogen levels by growing the ryegrass in aerated nutrient-culture solutions.



D. E. Williams records the gradation in symptoms—from severe to no nitrogen deficiency—of the ryegrass plants. Culture solutions contained eight different levels of nitrogen.

■ A method to determine plant nitrogen fertilizer needs during the growing season may prove useful on range forage crops, ARS scientists have demonstrated in laboratory experiments.

The method, developed in cooperation with the California Agricultural Experiment Station, consists of sampling plant tissue at prescribed times during the season for presence of nitrates as an indicator of the plant's nitrogen needs at the time of sampling.

Tissue sampling has an advantage over soil testing, the scientists say. It reflects accurately the plant's ability to acquire nutrients from the soil under existing conditions. Mere presence of the fertilizer in the soil does not prove the rate at which the plant is taking it up.

Researchers use Italian ryegrass

The sampling method was developed in laboratory experiments with Italian ryegrass by ARS range conservationists L. O. Hylton, Jr., and D. R. Cornelius; former ARS soil scientist D. E. Williams; and plant physiologist Albert Ulrich of the California station. Italian ryegrass is a forage annual commonly grown on Pacific Coast ranges. It often requires additional nitrogen for best growth there.

The scientists grew experimental plants indoors in nutrient solution; field trials will still have to be performed before recommendations can be made to growers.

They found that the youngest blade on a plant at sampling time is the most reliable above-ground indicator of available nitrogen in the plant. They also tested tissue from the second and third oldest blades and from the roots, stems, and selected top tillers.

In each test, the researchers measured plant yield (dry weight of the tops) produced by the available ni-

trogen and noted the narrow range between deficient and adequate concentrations of the nitrate in the tissues as reflected in the yield. The youngest blade proved to be the most sensitive indicator of nitrogen deficiency in these calculations.

The critical concentration level of nitrates in the youngest blade tissue was 1,000 parts per million. Under conditions of the experiment, any concentration below that level in this youngest tissue suggested that the plant needed additional fertilizer.

The scientists say that if the concentration of nitrates in the youngest blade ranges from 1,000 to 2,500 parts per million, it is highly questionable if the plant would respond to additional nitrogen. Beyond 2,500 parts per million, the plant definitely would show no response. If growers were to maintain a nitrate concentration in the youngest blade of at least 1,000 parts per million, through added nitrogen fertilizers, they could harvest optimum yields so far as this plant nutrient is concerned.

In the experiments, the researchers tested ryegrass plants ranging from those with a definite nitrogen deficiency to those getting more than adequate nitrogen. The yield of ryegrass tops leveled off when nitrates reached a concentration of 1,000 parts per million in youngest blade tissue.☆

COTTON SEEDCOAT

Hard seed fares best under wet field conditions

■ Two ARS scientists have shown that a hard, impermeable seedcoat on cottonseed provides a high degree of protection against field deterioration caused by heavy rainfall and high humidity.

Plant physiologist M. N. Christiansen and agronomist N. E. Justus conducted field experiments in Mississippi, which also showed that germination rates and oil quality of hard seed are largely unaffected by exposure to wet weather during the preharvest period. The experiments were conducted in cooperation with the Delta Branch of the Mississippi Agricultural Experiment Station and the National Cottonseed Products Association, Inc.

Hard seedcoats are common in many wild forms of cotton and insure persistence of the various lines despite the rigors of nature. Many cotton breeders have felt it would be valuable to breed this inherited characteristic into commercial cottons, to reduce the loss of cottonseed milling and planting quality, which occurs often in wet seasons.

Christiansen and Justus planted plots of hard seed (a selection from the Hopi variety) and permeable seed (a strain developed from the Delta Pine variety) in 1961 and 1962. In each year, they harvested seed three times—November, December, and January—following the main growing season.

In 1961, the weather was extremely dry while the bolls were forming from mid-September through October. In 1962, September was moderately rainy and October extremely rainy.

Results of the germination tests of seed from each of the harvests were tabulated as follows:

Percentage of Germination

	Hard Seeds		*Permeable Seeds*		
	1961	*1962*	*1961*	*1962*	*1962**
Nov.	94.	80.	96.	34.	59.
Dec.	96.	84.	89.	23.	40.
Jan.	91.	74.	51.	10.	16.

*Excluding rotted bolls.

These figures show that the germination rate of the hard seed remained above 90 percent after the dry (1961) season and fell no lower than 74 percent after the wet (1962) season. In contrast, permeable seed germination dropped from 96 to 51 percent after the dry season and from 34 to 10 percent after the wet season. Even with adjustments for the high degree of boll rotting, the adverse effects of wet weather on the germination of permeable seed were very pronounced.

Oil quality measurements followed the same trends as the germination rates, the scientists found. Cottonseed that is to be processed should be low in free fatty acids. The results were tabulated as follows:

Percentage of Free Fatty Acids

	Hard Seeds		*Permeable Seeds*		
	1961	*1962*	*1961*	*1962*	*1962**
Nov.	0.17	2.03	0.45	10.54	4.00
Dec.	.31	1.98	.63	11.57	5.71
Jan.	.39	2.72	2.41	13.38	10.42

*Excluding rotted bolls.

A TWIN ATTACK

Infrared Photography Identifies Saline Areas

■ An aerial photo detection system being developed by ARS agricultural engineers soon will enable scientists to identify salt-affected soil areas in the Lower Rio Grande Valley of Texas.

Farmers and researchers have needed a simple, rapid method of assessing the extent of salt accumulation in fields. Generally used methods, though highly accurate, are time consuming and require laboratory determinations from a large number of soil samples.

If farmers can locate salt-damaged areas before crop production is seriously affected, they can reclaim the land in time to prevent yield reductions in subsequent crops.

The aerial photo method, developed in cooperation with the Texas Agricultural Experiment Station, is based on two facts about cotton plants: (1) Cotton leaves from healthy plants reflect most of the light in the infrared portion of the light spectrum. (2) The highly salt-tolerant cotton plant shows symptoms of moisture stress directly in proportion to the amount of salt accumulation in the root zone. Leaves become progressively darker or dull bluish green, and plants are shorter as salinity increases.

Film records leaf symptoms

ARS agricultural engineers V. I. Myers and L. R. Ussery reasoned that photographic film sensitive to infrared rays might record the leaf symptoms of salt-caused moisture stress in cotton plants.

They took leaf and soil samples at 19 locations in dryland cotton fields near Weslaco, Tex. In the laboratory they measured reflected light with a reflectance spectrophotometer and determined the amount of salinity in the soil samples.

Leaves from cotton plants growing in soils having low salinity levels reflected significantly more light in the 700- to 800-millimicron wavelength range than leaves from plants in high-salt locations. This proved the scientists' hypothesis, because aerial infrared film with a dark-red filter is sensitive to wavelengths from 675 to 900 millimicrons.

Aerial photos of the fields, made the same day the leaf samples were collected, showed the variations in salt accumulation as expected.

Six shades, white to black

The engineers identified six shades of photographic tone in the photos, ranging from white (healthy plants) through shades of gray (salt-affected plants) to dark gray or black (bare soil), and they correlated the tones with soil-salinity levels determined in laboratory samples from the fields.

Experience gained in this research will be valuable in determining procedures for area surveys of soil salinity, the engineers say. Photographs of cotton fields will indicate salinity status of the soil to a depth of 4 feet.

Engineers cite main points

For accurate identification from aerial photos, the engineers offer this advice:

1. Photograph cotton fields that are approaching maturity. Aerial photos taken 3 weeks before cotton harvest show better definition of saline soil areas than photos made 5 weeks before harvest.

2. Make photos in the morning hours when moisture stress caused by salinity is most apparent.

3. Include in each photo mission a field of cotton where the salinity status of the soil has been determined by laboratory tests of soil samples.☆

Healthy plants appear in infrared aerial photos as light areas, salinity affected plants as shades of gray. Numbers indicate where leaf, soil samples were taken.

GAINST SALINITY

Fields are not completely affected by the saline condition, which appears as spotty damage in this nonirrigated corn.

Mulching With Cotton Gin Trash Aids Leaching

■ Here's a "recipe" for removing soluble salts from Lower Rio Grande Valley soils:

Take a barren plot of Raymondville clay loam soil, so saline it produces no crops. Cover the plot in March with a 5-inch layer of cotton gin trash (dried bolls, stems, and leaves). Leave the plot idle 6 months or longer: then plow and plant crops in the reclaimed soil.

ARS soil scientists C. D. Fanning and D. L. Carter used the above recipe in experiments near Weslaco, Tex., in cooperation with the Texas Agricultural Experiment Station.

Five months after applying 30 tons of mulch per acre, 84 percent of the salts had leached from the top 30 inches of soil. And the only water for leaching was 14½ inches of rainfall. The reduction in salt is not expected to be permanent; treatment every other year may be necessary.

Meanwhile, the salt concentration increased 43 percent between March and September in bare, untreated plots nearby.

Farmers of the Rio Grande Delta can use this reclamation method to correct the saline conditions that limit crop production on nonirrigated land. The water table in this area fluctuates, usually reaching high levels in April, July, and October. And evaporation rates are high in the subtropical climate. Salts are carried to surface soil layers with the ground water and are deposited there as the moisture evaporates.

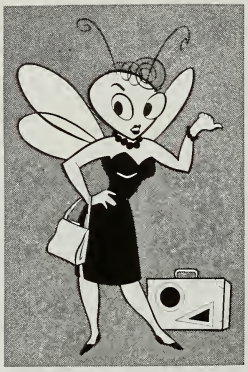
(If the gin trash comes from an area with verticillium wilt or other disease problems, it should be composted or steam-sterilized before being used as a mulch.)

Usually farmers depend on irrigation water or rainfall to leach out salt and prevent soil salinity from developing. But in nonirrigated fields of the Rio Grande Delta, salts accumulate faster than the 28-inch average annual rainfall can leach them away.

The scientists say the mulch reduces evaporation, thus limiting the amount of salt brought up and deposited in the surface soil layers. This reduction in salt buildup permits the limited rainfall to leach out salt that has already accumulated. Since the mulched soil remains moist, even light rains cause some leaching.

In other salt-removal experiments, Fanning and Carter found that a permanent ridge-furrow cultivation system (formed by a lister plow) also facilitated salt removal from spring through fall. Salt began accumulating again, however, during winter months when rainfall was low and the water table was high. The lister furrows on these plots were 38 inches apart, with the crests of the ridges 6 inches above furrow bottoms.

Between March and October, 87 percent of the salt was removed from the surface foot of soil below the furrow, where the soil remained moist and leaching occurred. The salt concentration in the ridges, however, was as great as in the untreated plots. The scientists say the ridge-furrow system might be useful for reducing salinity beneath the furrows just before seeding.☆



A HITCHHIKING BUG

Quarantine symbol alerts travelers at borders

■ At home, she's a hitchhiker; overseas, she's a stowaway. In either situation, this symbol plays an important role in an extensive campaign to gain the cooperation of travelers in observing plant and animal quarantines enforced by ARS inspectors at this country's international airports, seaports, and border crossings.

Motorists heading into Mexico for a 2-hour or 2-month stay below the border are being attracted to signs about U.S. agricultural quarantines by the winged hitchhiker. Although this marks the symbol's first appearance on highway signs, she's a familiar sight to travelers and ARS inspectors.

Wearing a grass skirt, the hitchhiking bug first appeared in Hawaii in August 1958 on cards placed in hotel rooms. The message asked travelers to cooperate with agricultural inspectors by not taking fruits and plants in their baggage to the Mainland, which is free of many damaging plant pests found in the islands.

The figure proved so useful in gaining travelers' attention that she has since appeared on several million fliers, folders, and posters. These notices, which now appear in five foreign languages and English, are distributed in the United States, abroad, and on trans-Atlantic liners bound for the United States.

The symbol highlights brief messages telling tourists that agricultural pests are international travelers, too, often hiding on innocent-looking fruits, plants, and meats.☆

FOOT-AND-MOUTH DISEASE

Plum Island researchers devise a way to purify virus

■ Techniques to produce a weekly quota of 1½ milligrams of foot-and-mouth disease virus have been devised by ARS chemists and physicists at the Plum Island Animal Disease Laboratory, Greenport, N.Y.

This essentially pure virus will be used in research aimed at improving methods for keeping foot-and-mouth disease out of the United States and for combating the disease if it should invade our livestock population.

Techniques for producing, concentrating, and purifying the virus were devised by chemist H. L. Bachrach and physicists Rodes Trautman and S. S. Breese, Jr. They grew the virus in large quantities of bovine kidney-tissue cultures and combined several newly devised chemical extraction and ultracentrifugation techniques to harvest the virus. Critical tests were then applied to make certain that the virus was free of all contaminating impurities.

Earlier electron miscroscope studies established that the virus, one of the smallest known, is a spherelike particle only 1-millionth of an inch in diameter. The new studies show that it is made up of about 30 percent ribonucleic acid (RNA), the core, and 70 percent protein, the outer covering.

When the RNA core, which is the disease-causing portion of the virus, was separated chemically from the protein, the RNA unraveled into a long, single-stranded molecule. It contained 24 percent guanine, 26 percent adenine, 28 percent cytosine, and 22 percent uracil, which are the genetic coding substances in the nucleic acid. The sequence of these components along the RNA strand is responsible for the reproduction in an infected animal of virus molecules that are identical to the parent molecule, thus spreading the disease.☆

A LIVING FOSSIL

Oriental ornamental—long thought extinct—is now being propagated

■ U.S. homeowners will soon have a chance to ornament their yards with a "living fossil"—a selected form of the beautiful Dawn Redwood tree.

A limited number of young trees are being distributed by botanic gardens and arboretums to the nursery industry for commercial propagation. These young trees were produced from stocks furnished by USDA's National Arboretum, Washington, D.C. USDA has no plants for distribution.

Until 1941, this tree was thought to have been extinct for millions of years. It was known only through fossil remains found in various parts of the world.

In that year, however, two interesting events occurred. The fossil was given a genus name, *Metasequoia*, by a Japanese botanist. And a living stand of trees was found in China.

Then, in 1948, two Chinese botanists reported that the living trees belonged to this same genus and named the species *Metasequoia glyptostroboides*.

A year earlier (1947), Harvard University's Arnold Arboretum financed an expedition that returned with seeds from these living fossils. Seedlings were started at the ARS Plant Introduction Station, Glenn Dale, Md., and several hundred were grown at the Arboretum for evaluation. The form selected, which has been named National, was chosen for its growth habit and desirable appearance.

Francis DeVos, assistant director of the Arboretum, points out that the National selection should not be confused with Metasequoias now available in the nursery trade. Buyers who desire the new ornamental should ask specifically for *Metasequoia glyptostroboides* National.

National is a deciduous conifer that resembles the bald cypress more closely than it does the redwood. It has a narrow-pyramidal growth habit and produces bright-green summer foliage that turns copper red in the fall. Grass and flowers grow well under its shade at the Arboretum. For optimum growth, the tree should have a moist site in full sunlight. It can be propagated from semihardwood cuttings taken in July or August.

At the Arboretum, National has attained a height of 35 feet in 10 years from seed and 11 feet in 5 years from cuttings. When fully grown, it can be expected to reach 65 to 70 feet, DeVos says.

The new ornamental has withstood temperatures as low as −2 degrees F. without winter injury, and Arboretum scientists believe it is hardy enough to take temperatures down to −10 degrees F. safely. No serious disease or insect problems have been encountered.☆

S. G. March propagates cuttings from the "living fossil" in a greenhouse at the National Arboretum.

The geologic formation and topography of this California orange and lemon grove make it a huge lysimeter.

A SCIENTIFIC FRUIT BOWL

■ A 1,000-acre commercial orange and lemon grove in California, on a site that functions almost like a huge lysimeter, is providing ARS scientists a rare opportunity to study salt buildup and irrigation water management under practical field conditions.

A lysimeter is a large container of soil set in the ground with its top flush with the surface of the undisturbed soil around it. By weighing the soil in the container, which rests on scales, researchers can measure runoff from a drainage area above the lysimeter or determine changes in moisture content in the lysimeter soil.

Though the soil of the citrus grove, near Riverside, cannot be weighed, scientists can measure the amount of water received and the excess that runs off almost as if it were in a lysimeter.

The unusual feature of the location is the combination of geologic formation and topography that directs all surface and subsurface flow to two points, where automatic recording instruments are located.

The Fallbrook and Vista very fine sandy-loam soils, only 2 to 5 feet deep, were formed in place by weathering of the decomposed granite that underlies them. A solid layer of granite below the soil is a barrier to deep percolation of water, and both surface and underground runoff drain across this solid granite where it lies exposed at the base of two deep ravines.

Management and irrigation of the young trees are controlled by the owners, who use sprinklers to irrigate the small trees and furrows to deliver water to larger trees. The land was not cultivated before the first trees were planted in 1957.

Results of one study at the citrus grove should have wide application in areas of five Western States that depend upon water from the Colorado River for irrigation. In this research, ARS soil scientist L. B. Grass and agricultural engineer Sterling Davis are measuring the effects of repeated irrigations with water containing a ton or more of salt per acre-foot.

Salt content is measured

The water district reports the amount of water delivered to the grove, and water flow instruments record the flow of water out of the watershed. Samples of both the irrigation and drainage water are collected weekly for chemical analysis. These data enable Grass and Davis to determine the salt left in the soil. Results are confirmed by laboratory tests of soil samples taken before and after the irrigation season.

Underlain by solid granite, the grove has natural outlets through which all drainage water flows.

Automatic equipment records all water that drains from the grove.

Soil salinity levels are lowest in the spring and increase to a seasonal peak in the fall, the scientists report, but winter rains wash out most of the salt that accumulates during the irrigation season. Between 1957 and 1962 the net increase—comparing springtime salt levels—has been only one-tenth of a ton of salt per acre, an insignificant amount.

By the end of the irrigation season the salt accumulation in the soil may approach the point where yield reduction can be expected, as it did last fall. However, most of the salt was in the surface 6 inches, above the rooting zone of the salt-sensitive citrus.

More serious than the total salt accumulation is the apparent gradual shift in proportion of sodium, calcium, and magnesium in the soil. Tests of soil and water samples indicate that sodium is not leaching out of the soil as rapidly as the calcium and magnesium. Citrus is specifically sensitive to high concentrations of sodium, and growth and yield may be affected even though the total amount of all salts in the soil is below harmful levels.

Irrigation efficiency is proved

Accurate records of water that is applied and that runs off also enable the scientists to estimate the efficiency with which irrigation water is used in the grove.

Water application efficiency is the percentage of water delivered to a field that is stored in the crop root zone. Efficiency is influenced by water intake rate of the soil, surface topography, evaporation, and amount of deep percolation below the root zone.

The soils at the grove take up water readily, and deep penetration to a water table does not occur; but evaporation rates are high in the arid California climate, and slopes of up to 10 percent promote runoff.

Under these conditions, irrigation efficiency in 1962 ranged from 59 to 76 percent and 48 to 66 percent on the two drainage areas that make up the 1,000-acre citrus grove.☆

Nutritional responses of three strains of rats give insight into . . .

HEREDITY AND FAT METABOLISM

■ The nutritional responses of three strains of rats to three different diets are providing ARS nutritionists with evidence that heredity may influence fat metabolism.

The responses also help account for conflicting results often reported by different laboratories where rats were fed similar diets.

Scientists now may be able to determine the genetic makeup of strains of rats that will respond to diets in a predictable manner. Experiments using laboratory animals are expected to help human nutritionists evaluate the influence of genetic characteristics on the body's use of different food components.

Rat strains used in the nutrition studies were Holtzman, Wistar, and BHE, a mixed strain.

Mary W. Marshall and Hazel E. Hildebrand, working at the Agricultural Research Center, Beltsville, Md., found that the differences among strains varied with the particular diet under study. Weight gain was similar for all strains when a standard laboratory diet was fed. But when the test diets were fed, the BHE and Holtzman rats ate more and gained more weight than the Wistar rats. The semipurified rations included known kinds and amounts of protein, fat, fiber, and minerals, in contrast with crude ingredients in the standard diet.

Metabolism of fat, not food intake, caused these differences in response, the scientists believe. Autopsy showed that the main differences were in the amount of fat and cholesterol retained in the liver, the amount of fat in the carcass, and the level of blood cholesterol.

The results also contribute to Beltsville studies concerning the influence of heredity on length of life as related to diet. The aim of these studies is to help people meet their nutritional needs over their lifetime.☆

A PEANUT MARKER

The curled leaf characteristic shows up clearly, in contrast with normal flat leaves.

■ Discovery of a leaf characteristic in peanuts, genetically controlled in a way that makes it valuable to scientists trying to develop improved peanut varieties, has been confirmed by an ARS geneticist.

This characteristic, crinkled (or curled) leaves in a plant that usually has smooth leaves, is easily visible at an early stage of plant development. Thus, it is of potential importance as a genetic marker in research to improve peanuts.

Geneticist R. O. Hammons demonstrated that the crinkle-leaf character is a dominant inheritance trait when introduced into a cross between two peanut lines. His experiments leading to this finding were conducted in cooperation with the Georgia Agricultural Experiment Station.

The immediate value of this leaf characteristic is in providing visual evidence, as early as 2 to 3 weeks after planting, that a peanut seed has one parent carrying the genetic marker—that cross-pollination has taken place. Peanuts have generally been considered self-pollinating. But the marker gene has enabled Hammons to show that an appreciable amount of natural crossing occurs—as much as 10 percent in some cases.

This information is an important addition to the basic understanding of peanut genetics. It means, too, that natural crossing can be used advantageously to develop large populations of first-generation hybrids, which will help speed breeding of improved peanut varieties. By taking advantage of natural crossing and the genetic marker, a breeder would be able to obtain natural-cross hybrids from known parents. The parents might also have known economic characteristics, such as disease and insect resistance and improved processing qualities, desired in the hybrid.

Until now, the only method of producing a peanut hybrid has been through controlled cross-pollination, a laboratory technique that requires keen eyes and deft hands. Because it is done by hand and is time consuming, controlled cross-pollination does not produce a large amount of seed in the first generation.

The crinkle-leaf characteristic is a natural mutation, found by W. F. Bryant, a farmer near Sidney, Tex. In 1954, Bryant furnished seed stock to the Oklahoma Agricultural Experiment Station, where Hammons obtained seed for his genetic studies.

The mutant line, a typical small Spanish peanut, has no promise as a commercial variety because of low seed yield.☆

PLASTIC FROM ROSIN

Has high strength and impact resistance

■ A tough plastic made of pine gum rosin is under development by ARS utilization scientists.

This new plastic—a polyester resin—is strong, lightweight, and easy to fabricate. It is of a type used in glass-fiber-reinforced plastic boats, automobile and truck bodies, construction panels, furniture, and home appliances.

Although additional research is needed to complete the development of this new product, the work has progressed far enough to indicate good possibilities that it will claim a share of the fast-growing market for polyester resins.

Research is being carried forward by ARS chemists N. J. Halbrook and R. V. Lawrence at the U.S. Naval Stores Research Station, Olustee, Fla. The new plastic reflects a continuing effort, through utilization research, to develop new uses for agricultural commodities.

The pine-gum-based product has some apparent advantages over petroleum-derived polyester resins now on the market, including a combination of high strength and impact resistance. The new resin has a low rate of water absorption and good resistance to alkalis and acids, indicating its potential value in making stronger and longer lasting plastic products reinforced with glass fiber. Cost of the new resin is expected to be within the range of the resins now in use.

During the past 5 years polyester resin production has jumped from about 100 million pounds to almost 200 million pounds annually.☆

Radioactive strontium and milk

A pilot-plant process that can remove more than 90 percent of radioactive strontium from milk will be evaluated on a commercial scale by a Missouri dairy cooperative under a contract with USDA and the Department of Health, Education, and Welfare.

The Producers Creamery Company will determine the commercial feasibility of the process and work out details for its operation on an industrial scale at the company's plant in Lebanon, Mo. The process was developed at the Agricultural Research Center, Beltsville, Md., as a cooperative project with the U.S. Public Health Service and the U.S. Atomic Energy Commission. Work was begun 3 years ago to develop the process for consideration in the event of nuclear emergency (AGR. RES., September 1961, p. 14).

In announcing the contract, USDA and HEW officials stress that present and foreseeable consumption of radiostrontium in milk and other foods is well below the level considered by the Federal Radiation Council to be an acceptable intake for a lifetime. However, because milk is a basic food, especially in the diet of infants and growing children, a standby decontamination process is needed that would also maintain the nutritional value, wholesomeness, and sanitary quality of the milk supply in the event of an emergency.

The commercial evaluation will involve scaling up the operation from a rate of 850 pounds of milk per hour to about 12,500 pounds and determining its potential for use in the average dairy plant. The processed milk will be dried and fed to experimental animals.

Studies are being done elsewhere on the nutritional, biochemical, and other aspects of milk that has gone through the radiostrontium removal process.

The process consists of filtering slightly acidified milk through columns of resin charged with mineral salts similar in composition to salts in milk. Radiostrontium ions in the milk exchange places with the mineral salts in the resin. The milk, freed of most of the radioactive strontium, has its excess acidity neutralized and is then pasteurized and homogenized.

A small beginning

Agricultural research often has a small beginning. These 13 seeds of a species of Lesquerella, *one of the mustard family, are all that were available for initial study of the oil of this potential new crop by the ARS Northern utilization research laboratory, Peoria, Ill. Their size is accented by the pencil point and the notebook reinforcing ring.*

Crambe wax shows promise

Experimental waxes made from the oil of crambe seed are additional evidence of this new-crop plant's industrial potential.

Key to crambe's industrial future is its high content (60 percent) of erucic acid, a fatty acid now obtained by U.S. industry from imported rape-seed oil (AGR. RES., November 1962, p. 6). Crambe oil contains 10 to 15 percent more erucic acid than rape-seed oil.

The crambe waxes are made by hydrogenating the oil or a derivative of it. Their properties are due mainly to the high molecular weight of erucic acid, say chemists T. K. Miwa and I. A. Wolff of the Northern utilization research laboratory, Peoria, Ill. Generally, the higher the molecular weight of fatty acids in an oil, the harder are the hydrogenated products and the higher are their melting points.

Hydrogenated crambe oil is a hard, glossy, white wax. The Peoria chemists have not yet tried it in applications research, but they have compared some of its properties with those of commercial waxes. For example, it melts at about the same temperature as beeswax but is considerably harder. Beeswax is used in making such items as cosmetics, crayons, candles, textile sizing, and polishes.

The wax made by hydrogenating liquid wax esters from crambe oil has a higher range of melting than the hydrogenated oil, but the wax is only about a fourth as hard. To obtain the liquid wax esters, fatty acids were reacted with fatty alcohols obtained by treating the oil with sodium.

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Speeds testing of rice

Small-scale versions of a rice milling machine and a rice polisher have been developed by an ARS research group to speed up testing of experimental varieties.

The new machines are expected to relieve a long-standing bottleneck in rice breeding—that of testing small samples of rice from plant selections for yield of milled rice. This yield is of critical importance to the rice industry. Up to now, performing the milling test has been a slow, tedious process.

The milling machine is capable of processing simultaneously either 80 rice samples in test tubes with a capacity of up to 5 grams or 48 samples in test tubes holding 5 to 15 grams.

The unit mills the rice by shaking it in the presence of an abrasive at 390 strokes per minute. The abrasive is either fused white aluminum oxide or washed quartz sand.

The polisher consists essentially of an electrically driven leather rotor turning inside a steel screen cup at 1,000 revolutions per minute. Soft chrome leather similar to the type used on industrial rice brushes performs the polishing. Rice is polished after milling to remove adhering particles of bran, germ, floury bits of endosperm, and abrasive material. Lab samples were formerly polished by hand in a cloth towel.

The rice milling machine and polisher were developed by agronomist J. E. Scott of the Texas Agricultural Experiment Station and ARS chemist B. D. Webb and agronomist H. M. Beachell.

Research is consolidated

Research on human nutrition and consumer use has been merged with research on the utilization of farm commodities under one deputy administrator of ARS.

B. T. Shaw, administrator of ARS, says that the merger will integrate the consumer-oriented research of both programs. "The efforts of utilization scientists to develop new foods and food processes and new qualities for cotton and wool fabrics tie in closely with studies of human nutrition, clothing, and home furnishings," he says.

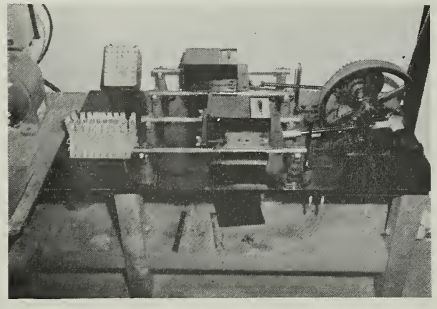
The combined program of Nutrition, Consumer and Industrial Use Research, which became effective July 1, is headed by G. W. Irving, Jr., formerly ARS deputy administrator for utilization research and development. His chief aides are Ruth M. Leverton and W. D. Maclay.

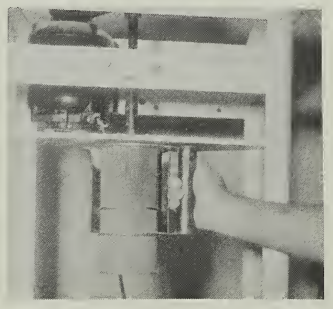
The seven divisions brought together in the merger are human nutrition research and clothing and housing research, both at Beltsville, Md., consumer and food economics research, in Washington, D.C., and the four regional utilization research and development divisions in New Orleans, La., Wyndmoor, Pa., Peoria, Ill., and Albany, Calif.

The merger followed the retirement of Hazel K. Stiebeling as deputy administrator for nutrition and consumer use research. She had been associated with USDA since 1930 and headed research in human nutrition and home economics for 18 years.

Her contributions to human nutrition in the United States brought her worldwide recognition, and in 1959 she became the first woman to receive the Presidential Award for Distinguished Civilian Service.

The milling machine (left) shakes small samples of rice in test tubes containing an abrasive. The rice is then polished (right).





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